LITE Leeds Institute for Teaching Excellence

UNIVERSITY OF LEEDS

Immersive Approaches in Geoscience Education: Exploring XR Applications and Student Perspectives

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A LITE Fellowship Snapshot Report

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Project overview

This project aimed to enrich applied geoscience education through the strategic application of extended reality (XR) technologies, including web-based virtual reality (webVR), headset virtual reality (VR), and mixed reality (MR), across undergraduate and postgraduate programmes. It focused on developing XR interventions that complement existing field teaching or provide standalone experiential access to sites that are inaccessible, impractical, or unsustainable to visit, with the aim of improving student engagement, inclusivity, and geospatial understanding. Fieldwork is central to geoscience learning, but it presents ongoing challenges related to physical accessibility, time constraints, and environmental limitations. XR offers interactive and immersive experiences that can help address these barriers while supporting active and experiential learning.

The project aligns with the University's Digital Education Strategy and the launch of the Helix XR teaching space, responding to growing sector-wide interest in immersive pedagogy. Beneficiaries include students seeking flexible, repeatable, and inclusive learning opportunities, as well as educators exploring innovative and sustainable teaching approaches. The findings and best practices extend beyond geoscience, offering transferable insights into the design, implementation, and evaluation of XR in higher education. This project builds on established research in geoscience education addressing challenges in geospatial visualisation (Janeras et al., 2022) and access to field-based learning through virtual field trips (Pugsley et al., 2022), extending this work through the application of immersive XR approaches in taught programmes.

Project objectives

- Develop and embed immersive XR learning experiences (webVR, VR, and MR) that complement existing field teaching and provide meaningful experiential access to field sites that are inaccessible, impractical, or unsustainable to visit.
- Evaluate student experiences of XR-enhanced learning using a mixed-methods approach, combining quantitative and qualitative feedback to inform iterative refinement of resources and teaching practice.
- Establish and share best practice guidelines for XR integration across disciplines.

Methods

The project combined the development of immersive XR learning resources with a mixed-methods evaluation of student experiences (Figure 1). XR resources were embedded within taught undergraduate and postgraduate geoscience modules and included web-based virtual field experiences, headset VR activities, and collaborative mixed reality teaching sessions.

XR learning experiences were implemented in two main contexts: a fully virtual field trip of the Jurassic Coast for MSc Engineering Geology students, and a web-based virtual twin of

an existing field trip to Ilkley for BSc Applied Geoscience students. These resources integrated 360° imagery and videos, drone- and lidar-derived 3D models, embedded teaching videos, and interactive activities such as virtual measurements, annotations, and engagement with multiple data types.

Student experiences were evaluated through post-activity questionnaires completed by over 80 undergraduate and postgraduate students across five survey deployments (three linked to the Jurassic Coast virtual field trip and two linked to the Ilkley virtual twin). The questionnaires combined 7-point Likert-scale questions with open-ended responses. Quantitative feedback was used to explore trends in engagement, accessibility, and perceived learning value, while qualitative responses were analysed thematically following Braun & Clarke (2006) to capture student perspectives.

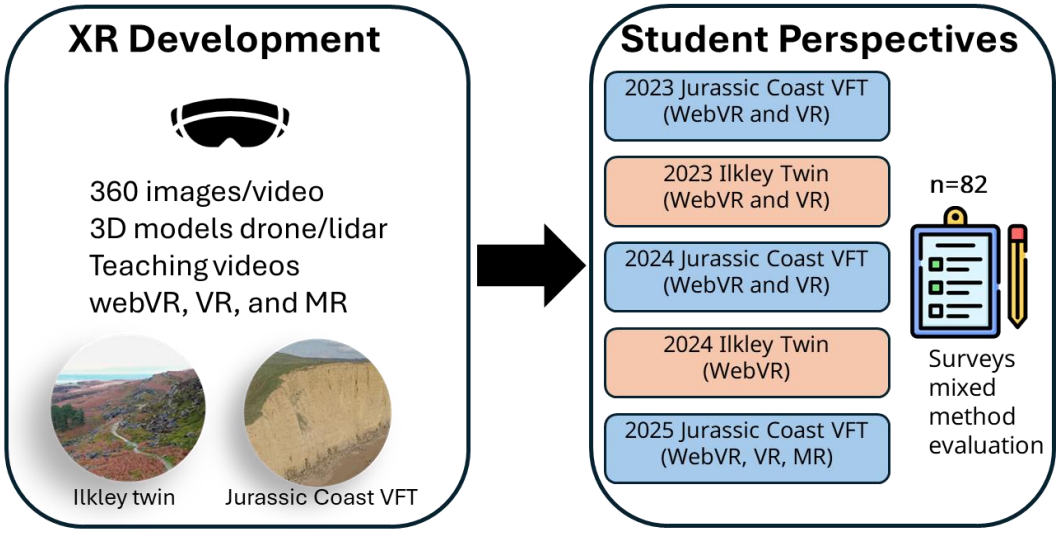

Figure 1: Overview of XR resource development and deployment across undergraduate and postgraduate geoscience programmes, and the mixed-methods evaluation of student experiences.

Key findings

The following key findings capture the main educational impacts of the project and are summarised in Figure 2:

• XR increased student engagement with learning. Students reported high levels of interest, focus, and involvement, supporting engagement with geological concepts and learning activities.
• XR as part of a virtual field trip enhanced students' geospatial understanding, spatial reasoning, and perception of scale. Immersive visualisation helped students interpret terrain, geological structures, and the relative size and scale of hazards and

landform features that are difficult to grasp through maps, photographs, or 2D projections.
• Flexible and repeatable access to XR alongside fieldwork reduced physical, logistical, and time-related barriers, while increasing student confidence and supporting learning consolidation and revision. Students consistently viewed XR as a complement to, rather than a replacement for, traditional fieldwork.
• Different XR implementations supported different learning preferences and needs. Within this project, collaborative mixed reality sessions were perceived as more comfortable and less disorienting, while the headset VR implementation was valued by learners who preferred self-directed learning.
• Reported challenges included technical issues, headset discomfort, and occasional motion sickness, highlighting the need for preparation, technical support and alternative access options.

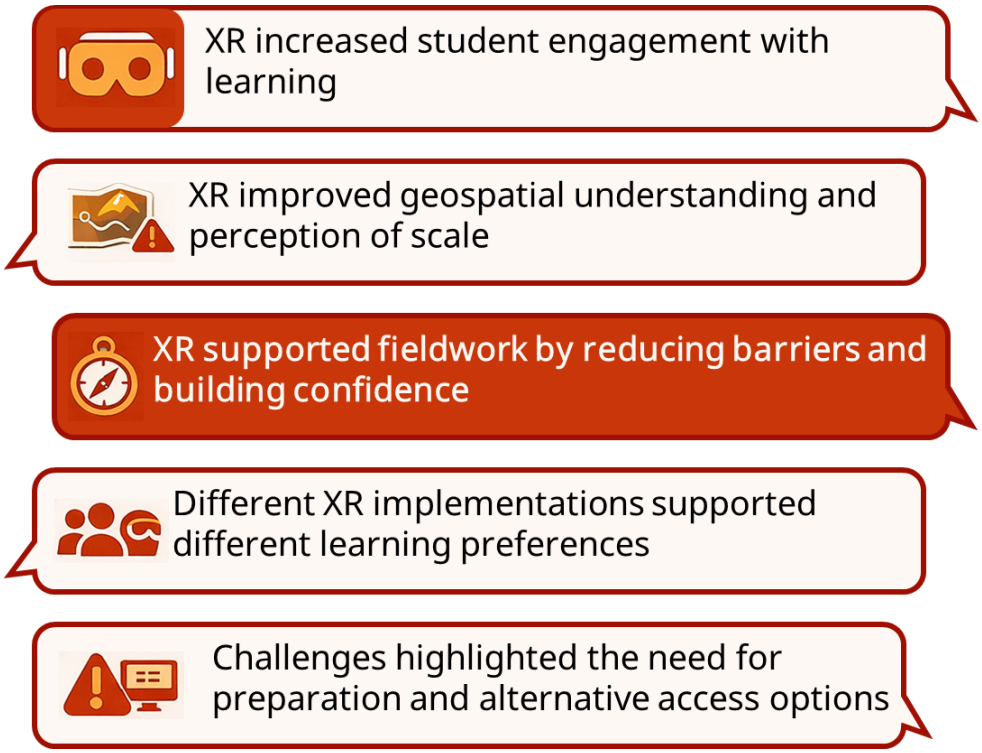

Figure 2: Summary of key findings from the XR fellowship project.

Implications for practice

- [Insert implications for practice]XR can effectively bring field sites into the classroom, offering immersive learning experiences when visiting sites is not possible, practical, or environmentally sustainable.
- Institutions should provide appropriate training, software, and technical support to enable effective XR adoption and reduce implementation friction, addressing the technical and practical challenges identified in this project.

- Student feedback strongly supports the adoption of XR as a complement to traditional fieldwork, not a replacement, ensuring experiential and skill-based learning outcomes are maintained.
- Best practice guidelines are needed to support wider XR implementation across disciplines, and this project contributes evidence to those guidelines.
- Findings from the project are informing ongoing discussions around digital education and immersive learning, including through participation in a UK-wide Jisc working group shaping national guidance on mixed reality in higher education.

Outputs

The fellowship produced multiple XR resources, including the Jurassic Coast Virtual Field Trip and Ilkley Virtual Twin, incorporating 360° imagery, drone footage, and interactive activities. The webVR resources are available to view using the following links:
• Jurassic coast virtual field trip and webVR experience
• Ilkley virtual twin in webVR

Mixed reality teaching demonstrations developed through the project can also be viewed via:
• Mixed Reality demo 1
• Mixed Reality demo 2

Additional outputs include conference presentations at the Virtual Geoscience Conference and the Medea Conference, as well as recognition through awards such as the Innovation Partnership Award and the Audience Favourite Medea Award. Beyond the development of XR resources, the fellowship contributed to VR guidance produced by the Digital Education Enhancement team and to sector-level discussions through participation in the ALT/Jisc UK XR Working Group.

Challenges

Developing XR learning resources was time- and resource-intensive, requiring significant effort to capture high-quality imagery and video, build 3D models, and ensure reliable functionality. This work demands a team-based approach and a high level of technical expertise. A key lesson from the project was the importance of starting small and tying XR development to clearly defined learning objectives. Sharing XR resources can help reduce start-up overheads, and future work should prioritise capturing XR content during existing site visits using accessible and easy-to-use reality-capture tools.

Sustained institutional support for software, hardware, and staff training is essential to reduce friction and support long-term XR adoption. Student familiarity with XR varied

considerably, highlighting the need for preparation and onboarding sessions to ensure a smoother teaching experience. Teaching staff should not be expected to troubleshoot technical issues during sessions; the presence of trained support demonstrators was critical to the successful delivery of XR-based learning activities.

Within VR environments, navigation challenges and disorientation were common and can be mitigated through the use of detailed maps, clear wayfinding, and structured guidance. One important insight was that students generally preferred mixed reality (MR) teaching sessions, which were perceived as more comfortable, interactive, and collaborative, and were typically easier to develop than fully immersive VR representations of field sites.

Finally, designing inclusive XR sessions requires the provision of alternative access options, such as screen sharing or desktop-based viewing. Not all students are comfortable using immersive technologies, and confidence develops over time. Maintaining a balance between XR and traditional fieldwork therefore remains essential to meeting programme learning outcomes and supporting diverse student needs.

Next steps

Future work will focus on incremental improvements to existing XR implementations, informed by ongoing student feedback, alongside wider dissemination of project findings across disciplines. Contributions will extend to the cross-faculty Living Labs project on virtual site visits, supporting sustainable and innovative approaches to teaching beyond geoscience.

A key priority is continued participation in XR guidance development through the ALT/Jisc UK XR Working Group, contributing experience and evidence to national discussions on the use of augmented and mixed reality in higher education. Planned academic outputs include publishing project findings in peer-reviewed journals and developing open-access XR resources to support wider adoption and reuse.

Further impact will be supported through collaboration with geological societies to extend the reach of the work beyond Leeds, as well as through ongoing international engagement initiated during presentations, helping to strengthen global partnerships. Together, these activities aim to sustain impact, promote resource sharing, and support the University of Leeds' role in immersive pedagogy and digital education strategy.

Colleagues interested in developing XR resources, sharing best practice, or exploring cross-disciplinary applications are warmly invited to collaborate.

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